SOUTHWESTERN RANGE & SHEEP BREEDING LABORATORY

FORT WINGATE, NEW MEXICO

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
COOPERATING WITH THE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
AND THE
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

1959-60 REPORT

THIS REPORT OF RESEARCH PROJECTS NOT YET COMPLETED IS INTENDED FOR THE USE OF ADMINISTRATIVE LEADERS AND WORKERS IN THIS OR RELATED FIELDS OF RESEARCH, AND NOT FOR GENERAL DISTRIBUTION.

INDEX

INDEX, CONTINUED

INDEX OF TABLES

INDEX OF TABLES, CONTINUED

OBJECTIVES

The principle objective of this laboratory is the development of types of sheep which are adapted to the semi-arid range conditions of the Southwest, and to the economic requirements of Navajo Indians and other sheep producers of this area. In the pursuit of this objective, it has been the policy to employ basic breeding methods that can be used by other stockmen of this area. Values of the wools are studied, and the selection of breeding animals is based on production records as measured under range environmental conditions. Emphasis has been placed on adaptability and longevity of the sheep, yield of wool and its suitability for hand weaving and commercial manufacture, and the quality and quantity of lambs produced.

OUTLINE OF RESEARCH PROGRAM

In order to achieve the above objectives, the research program of the Southwestern Range and Sheep Breeding Laboratory is conducted under the authority of five research projects. Four of these projects are investigated exclusively at Fort Wingate. Three of them deal primarily with sheep breeding, while the fourth is concerned with investigations of wool and its various qualities. These four projects provide for maximum utilization of the sheep maintained at Fort Wingate and the records obtainable from them.

The fifth project is conducted at University Park, New Mexico in cooperation with the New Mexico State Agricultural Experiment Station. It is part of a larger project, with other phases of the work being conducted at Dubois, Idaho; Tifton, Georgia; and Beltsville, Maryland. The five projects are as follows:

AH b1-10 Improvement of Navajo sheep by line breeding and selection within the Navajo strain.

AH b1-11 Improvement of fine wool sheep under southwestern conditions.

AH b1-12 Improvement of coarse wool sheep for the production of wool suitable for Navajo hand weaving.

AH b5-6 Investigations of wool for the improvement of Navajo, Navajo crossbred, Targhee and Targhee crossbred sheep under southwestern range conditions.

AH b3-8 Influence of environment at different geographic locations on fleece and body traits of sheep. This is a U.S.D.A. contributing project to the Western Regional Project W-46: The effects of environmental stresses on range cattle and sheep production.

ROSTER OF PERSONNEL

Name	Title	Date Entered on Duty	Duties
Stanley L. Smith	Animal Husbandman	Jul. 23, 1952	Director
Earl E. Ray	Animal Husbandman	Oct. 6, 1958	Genetics
Gordon L. Jessup, Jr. [1]	Animal Husbandman	Mar. 17, 1952	Sheep Investigations
Jack L. Ruttle [2]	Animal Husbandman	Aug. 26, 1957	Sheep Investigations
Alison S. Dodge	Clerk (Stenography)	June 3, 1951	Clerical
Glenn C. Perkins	Labor Supervisor	Sept. 24, 1954	Operations
Jimmie Gleason	Maintenance Man	Apr. 1, 1942	Maintenance
Fred Deschene	Labor Leader	Oct. 2, 1947	Camp Tender
Calvin Gleason	Laborer	Sept. 4, 1956	Miscellaneous
Sam Martinez [3]	Animal Caretaker	Apr. 9, 1956	Sheepherder
Kee Cayateneto [4]	Animal Caretaker	Aug. 4, 1957	Sheepherder
Bahozhonie W. Begay	Animal Caretaker	Nov. 2, 1959	Sheepherder
Sam Sage	Animal Caretaker	Jan. 5, 1960	Sheepherder

1. Gordon L. Jessup, Jr. in leave without pay status from September 21, 1957 until July 11, 1960 in order to pursue graduate studies at Oregon State College, Corvallis, Oregon.

2. Jack L. Ruttle resigned effective January 9, 1959.

3. Sam Martinez resigned effective December 2, 1959.

4. Kee Cayateneto resigned effective August 13, 1959.

PUBLICATIONS

The following papers have been published since the establishment of the Southwestern Range and Sheep Breeding Laboratory:

1. The Navajo Sheep Industry and Needs for Its Improvement:
   J. M. Cooper, The Sheep Breeder, May 1939. (Out of Print).

2. The Sheep Industry of Indians in the Southwest:
   J. M. Cooper and Dewey Dismuke, Indians at Work, August, 1939. (Out of Print).

3. Breeding for Adaptability to Local Conditions, with Special Reference to Sheep on the Navajo Indian Reservation:
   J. M. Cooper, American Society of Animal Production, 1939. (Out of Print).

4. Improvement of the Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, March 1940.

5. Breeding for Quality Wool:
   James O. Grandstaff, The National Wool Grower, July, 1940. (Out of Print).

6. A Rapid Method for Projecting and Measuring Cross Sections of Wool Fibers:
   James O. Grandstaff and Walter L. Hodde, Circular No. 590, U. S. Department of Agriculture, December 1940.

7. Evaluating Fleece Characteristics of Navajo Sheep from a Breeding Standpoint:
   James O. Grandstaff, Rayon Textile Monthly, October-November 1941.

8. Wool Characteristics in Relation to Navajo Weaving:
   James O. Grandstaff, Technical Bulletin No. 790, U. S. Department of Agriculture, January 1942.

9. Characteristics and Production of Old-Type Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, May 1943. (Out of Print).

10. The Influence of Seasonal Differences on the Growth of Navajo Lambs:
    Cecil T. Blunn, Journal of Animal Science, February 1944. (Out of Print).

11. A Preliminary Report on the Post-Natal Development of the Fiber Characteristics of the Fleeces of Navajo Sheep:
    James O. Grandstaff and Cecil T. Blunn, Journal of Animal Science, May 1944. (Out of Print).

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PUBLICATIONS, CONTINUED:

12. Comparison of the Yields of Side Samples from Weanling and Yearling Sheep:
Cecil T. Blunn and James O. Grandstaff, Journal of Animal Science, May 1945.

13. Yearly Differences in Growth of Navajo and Crossbred Ewe Lambs:
Cecil T. Blunn, Journal of Animal Science, August 1945.

14. Evaluating Fleece Quality of Navajo Sheep from Small Samples:
James O. Grandstaff and Cecil T. Blunn, Journal of Agricultural Research, September 1945.

15. Improvement of Wool for Navajo Hand Weaving:
James O. Grandstaff and Cecil T. Blunn, Indians at Work, March 1945. (Out of Print).

16. Relation of Kemp and Other Medullated Fibers to Age in the Fleeces of Navajo and Crossbred Lambs:
James O. Grandstaff and Harold W. Wolf, Journal of Animal Science, May 1947.

17. Comparison of Corriedale x Navajo and Romney x Navajo Crosses:
James O. Grandstaff, Journal of Animal Science, November 1948.

18. Size of Lambs at Weaning as a Permanent Characteristic of Navajo Ewes:
George M. Sidwell and James O. Grandstaff, Journal of Animal Science, August 1949.

19. Adaptation of Livestock to New Environments:
James O. Grandstaff, for publication in Proc. United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success, New York, 1949.

20. Fertility and Reproduction in Sheep in Relation to Breeding and Environment:
James O. Grandstaff, presented at International Symposium on High Altitude Biology held at Lima, Peru, South America, November 23-30, 1949.

21. Genetic and Environmental Factors Affecting Staple Length in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, James O. Grandstaff and Donald A. Price, Journal of Animal Science, February 1951.

22. Lamb Production of Navajo Ewes Bred to Columbia and Romney Rams, and Navajo Crossbred Ewes Bred to Lincoln and Cotswold Rams:
Donald A. Price, James O. Grandstaff and George M. Sidwell, Journal of Animal Science, February 1951.

PUBLICATIONS, CONTINUED:

23. Genetic and Environmental Factors Affecting Type and Condition in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, Donald A. Price and James O. Grandstaff, Journal of Animal Science, May 1951.

24. Effects of Some Genetic and Environmental Factors on Yearling Traits of Navajo and Navajo Crossbred Ewes:
Donald A. Price, George M. Sidwell and James O. Grandstaff, Journal of Animal Science, November 1953.

25. Some Aspects of Twin Vs. Single Lambs of Navajo and Navajo Crossbred Ewes:
George M. Sidwell, Journal of Animal Science, February 1956.

26. Estimation of Clean Fleece Weight from Small Side Samples and from Wool Density, Body Weight, Staple Length and Grease Fleece Weight:
George M. Sidwell, Gordon L. Jessup, Jr. and W. D. McFadden, Journal of Animal Science, February 1956.

27. Some Factors Influencing Fiber Diameter in Yearling Ewe Fleeces:
George M. Sidwell and Gordon L. Jessup, Jr., Western Section Meetings of the American Society of Animal Production, Reno, Nevada, July 16-18, 1956.

28. A Comparison of Five Methods of Estimating Clean Fleece Weight:
George M. Sidwell, P. E. Neale and Gordon L. Jessup, Jr., Journal of Animal Science, August 1958.

29. Tests Reveal Importance, Influence of Large Bodied, Weighty Ewes:
Jack L. Ruttle, The National Wool Grower, October 1958.

30. Effect of Age on the Selection of Rams:
Jack L. Ruttle and George M. Sidwell. Sheep and Goat Raiser, February 1959. Also published under the title, Beware of Judging Strictly by Size, in The National Wool Grower, May 1959.

TABLE 1. SUMMARY OF PRECIPITATION

	Fort Wingate				El Morro		
	Average 1864-1911	Average 1938-1958	1959	1960	Normal	1959	1960
January	.96	1.06	.19	1.11	.93	.47	1.12
February	1.42	.65	.76	1.12	.84	.22	.81
March	1.02	.95	.18	.44	1.18	.17	.39
April	.98	.65	1.25	.34	.60	.84	.44
May	.58	.65	T	.63	.41	.02	.61
June	.69	.51	1.00	.40	.53	.64	.52
July	2.34	1.97	.38	.71	1.80	.88	..87
August	2.31	2.12	1.93	.60	2.76	4.80	.59
September	1.37	1.17	.47	.26	1.46	.14	.32
October	1.05	1.06	2.53	2.30	1.01	2.32	1.78
November	.76	.65	.45	.32	.52	.03	.13
December	.97	.95	1.44	.58	1.03	1.19	.45
ANNUAL	14.45	12.39	10.58	8.81	13.07	11.72	8.03

The above table summarizes the precipitation at Fort Wingate and El Morro, New Mexico. El Morro data is presented because the ewes and lambs are grazed on El Morro range for a large part of the year and because there are sometimes appreciable differences in the amounts of precipitation between the two locations. Data at Fort Wingate from 1938 to the present have been compiled from station records. All other data have been secured from the U. S. Weather Bureau reports.

WEATHER CONDITIONS

1959

With the exception of the months of April, June, October and December, the year of 1959 was considerably drier than average at Fort Wingate. Total precipitation recorded at the Laboratory amounted to 10.58 inches.

Rainfall at El Morro, also, amounted to only 90 percent of normal in 1959, with an annual total of 11.72 inches, 4.80 inches of which fell during the month of August.

1960

Fort Wingate shows only two years, on record, which were drier than 1960. Total 1960 precipitation amounted to 8.81 inches; in 1956, total precipitation was 8.12 inches, and in 1950, precipitation recorded at Fort Wingate totaled only 6.06 inches.

There was more water on the El Morro range during the spring of 1960 than at any time during the previous ten years, although total annual precipitation was only 61 percent of normal, amounting to 8.03 inches.

SUMMARY OF OPERATIONS, 1959

Weather and range conditions were not considered good in 1959, although later than usual summer rains brought the grass along to average or better. Late arriving frosts permitted growth and curing of the forage until late in the fall.

The acquisition of a small bulldozer enabled the building of roads and some water holes on areas of the Ft. Wingate range not previously used. The dry summer made it necessary to use all of the available range at Ft. Wingate because the El Morro range had no water or grass until after the rains in late August. Benefits from the 1958 cabling of approximately 1500 acres of our east range began to pay off in 1959 as the trees had died and sheep could graze between them. More pinon and juniper eradication would further increase the grazing potential.

Due to a gradually diminishing flow from two springs near headquarters, it became necessary to drill a well. One was completed in June, 1959 which produced on test 50 GPM from a depth of 135 feet. The water stands at 68 feet, measured from the top of the well, and has a four foot draw down when pumped at a rate of 34 GPM. No shortage of water has been experienced since the well was put into operation.

In previous years the ram lambs have always been herded in a separate flock from weaning time until placed in a dry lot for feeding, in December. In 1959, when grass became available, they were turned loose in one of the fenced pastures at Ft. Wingate. Gains were exceptionally good throughout the fall and early winter, but it became necessary to put them on feed in January, 1960. Colder than usual winter weather, plus considerable snow, brought the coyotes in, and losses were mounting. After having been fed for the remainder of the winter, the fall gains were still apparent when they were weighed as yearlings in June, 1960.

The second fenced pasture was completed early in 1959 by enclosing the area between the railroad and U. S. 66 highway. It is not a large area, having been calculated at 800 acres from aerial photographs. The carrying capacity is much greater than comparable range, however, due to the Rio Puerco running through it, diagonally. The mature rams feed almost exclusively on weeds, grass and browse growing in the arroyo of the Rio Puerco during the summer months. A dependable water supply is badly needed in this pasture, and it has become obvious that a well will have to be drilled in the near future.

The mature rams have not been herded since the completion of the south pasture in 1958.

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Supplemental feeding during the winter months has been followed with both the ewe and ewe lamb herds. The rate was approximately one third and one fourth pounds per head daily, respectively, but the mature rams are not fed. The supplement fed is a pellet composed of seventy percent alfalfa, 20 percent milo and 10 percent molasses.

SUMMARY OF OPERATIONS, 1960

The winter of 1960 was much colder than usual, with considerable snow. Due to crusted snow at El Morro, the sheep wintered on the Ft. Wingate range. Consequently, the El Morro range was far better in the spring than the Ft. Wingate range, with water holes filled and plenty of new growth. The yearling ewes were first trucked to El Morro after shearing and dusting in late April. They were followed by ewes with lambs, in May, when the lambs were old enough.

The lease on the range at El Morro terminated on June 30, 1960 and a new range near Ramah, about 14 miles to the west, was leased from Mr. Vance Bond. The sheep were trailed from the El Morro range to the Bond range at the end of June. The usual summer rains failed to make their appearance, so the range condition appeared critical by early August. The Bond range has more than adequate water developments so there was no shortage of water, as had often been experienced on the El Morro range. In spite of the apparent lack of grass during the summer, some groups of lambs had heavier than average weights when weighed in September than they had ever had before.

When the sheep were trucked from the Bond range to Ft. Wingate in late November, there was no grass left anywhere. There can be no further grazing without damage to the range and loss of sheep until adequate soil moisture conditions are restored. Reserve forage at Ft. Wingate was adequate to carry the sheep until April, 1961. If no spring moisture is received, it will be necessary to support the sheep on pellets until the summer rains come.

Insufficient grass and predator trouble made it necessary to put the ram lambs on feed early in the fall of 1960.

A continuing program in cooperation with the Agricultural Research Service Animal Parasite Research Laboratory of Albuquerque, to find a practical and efficient means for controlling head grubs (Oestrus ovis), has existed for several years. The use of Dow's ET - 57 was effective but it also induced fever and a break in the wool fiber. After experience was gained with dimethoate (an organic - phosphate compound), the entire flock was treated with it in December, 1960. It is almost 100 percent effective in destroying first and second instars, but the dosage must be closely adjusted for the body weight of each sheep.

The third and largest pasture, which encloses approximately four sections of land, was fenced in during 1960, with the exception of three water gaps. This is the most accessible portion of the east range, and it also has the greatest carrying capacity.

Two steel buildings that have been needed for some time were acquired in 1960; one will be used for storage and the other for weighing, lambing, shearing and semen testing. These buildings were acquired from State funds.

The rams were not left with the ewe flock during the winter as pasture forage was adequate.

TABLE 2. OUTLINE OF BREEDING PROGRAM

Breeding Group Designation		Breeding of Rams	Breeding of Ewes	No. of Rams Each Year	Number of Ewes Breeding Season		Research Line Project
					1958-59	1959-60	
No.	Letter						
1	N	Navajo	Navajo	3	116	108	AH-bl-10
13	F	Finewool	Finewool	3	114	116	AH-bl-11
25	T	Targhee	Targhee	6	72	73	AH-bl-11
22	D	Targhee	Targhee x Reservation	10	106	117	AH-bl-11
21	R	Rambouillet	Rambouillet x Reservation	10	114	110	AH-bl-11
20	S	Reservation	Reservation	10	112	122	AH-bl-11
16	C	Coarsewool	Coarsewool	4	119	123	AH-bl-12
23	L	Coarsewool	Coarsewool x Reservation	10	113	113	AH-bl-12
Totals				56	866	882	

SUMMARY OF BREEDING PROGRAM

The Navajo breeding group of sheep are descended from the original old type Navajo sheep obtained by the Laboratory in 1935. They have been maintained as a closed line with improvement derived entirely through selection.

The Coarsewool line is made up of the offspring from the following matings and the reciprocals thereof:

$$(K \times N)[C_2 \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}] \times [L \times \begin{matrix}(C_1 \times N)(R_1 \times N)\\(R_1 \times N)(C_1 \times N)\end{matrix}] (R_1 \times N).$$

This line has been closed since 1954 when final crosses were completed. Further improvement will be based on selection and breeding within the line.

The Finewool line is composed chiefly of the offspring of Targhee rams bred to $(C_1 \times N)(R_1 \times N)$ and $(R_1 \times N)(C_1 \times N)$ ewes. It also contains offspring of Debouillet and Merino rams bred to the same type ewes and Rambouillet rams mated to Navajo ewes. This line has also been closed since 1954 when final crosses were completed. Improvement will be continued by selection and matings within the line.

Group 25 is of purebred Targhee breeding. One hundred ewes were purchased in Idaho and Montana, and first bred in 1954. This line has been slow to adapt to New Mexico conditions, with the result that it has been difficult to maintain numbers. Rams representing several inbred and control lines are obtained from the U. S. Sheep Experiment Station, Dubois, Idaho to serve the dual purpose of improving the Fort Wingate sheep and of testing the lines produced at Dubois.

Ewes in groups 20, 21, 22 and 23 are average Navajo Reservation ewes obtained in 1952-53, or the offspring of these ewes. The original ewes were predominately of low grade Rambouillet or Merino breeding.

Group 20 is a control group. The rams are of the same breeding as the ewes. In group 21, the rams are good quality Rambouillets obtained from the Navajo Tribal Ram flock, at Sanders, Arizona. The rams used in group 22 are purebred Targhees, and are either obtained from the U. S. Sheep Experiment Station, Dubois, Idaho, or are produced at Fort Wingate in breeding group 25. Rams used in group 23 are of coarsewool breeding and are produced at Fort Wingate in group 16.

SUMMARY OF BREEDING PROGRAM, CONCLUDED.

Selection in groups 21, 22, and 23 is on the ewe side only. All ram lambs are discarded, and new rams of designated breeding are used each year. In the control group (group 20), selection of both rams and ewes is made at random.

EFFECTS OF PREGNANCY AND LACTATION ON WOOL PRODUCTION

The effects of pregnancy and lactation on wool production of range ewes were investigated, using the records of 784 ewes at Fort Wingate. Preliminary results show that the ewes which gave birth to a lamb produced less clean w ool than a dry ewe, and that ewes which weaned a lamb produced less clean wool than ewes that gave birth to a lamb but failed to raise it. Ewes giving birth to twins and weaning twins produced 1.2 pounds or 25 percent less clean wool than ewes which were dry. The ewes giving birth to singles and weaning singles produced 0.8 pounds or 17 percent less clean wool than ewes which were dry. These figures indicate that the lamb production of the ewe should also be considered when selecting ewes on the basis of their wool production.

THE EFFECT OF BODY WEIGHT OF EWES ON BIRTH AND WEANING WEIGHTS OF LAMBS

The effect of body weight of ewes at breeding time on birth and weanling weights of subsequent lambs was examined at Fort Wingate. Body weights of 716 ewes taken at breeding time were related to the subsequent lamb production. The results indicate that each pound increase in body weight of the ewes results in 0.09 pound increase in birth weight and 0.17 pound increase in weaning weight of the lambs. It was also found that for each pound increase in birth weight of lamb there was 5.8 pounds increase in weaning weight.

RELATIONSHIP BETWEEN BIRTH WEIGHT AND RATE OF SURVIVAL

The relationship between birth weight and rate of survival of offspring was studied at Fort Wingate from the records of 2,238 ewes. Birth weights ranged from 3.0 to 13.9 pounds and were separated into one pound class intervals. Survival percentages for single and twin lambs are shown in the following table:

Birth Weight of Lambs (Pounds)	Percent of Lambs Surviving	
	Single Lambs	Twin Lambs
3.0 - 3.9	0	0
4.0 - 4.9	67	56
5.0 - 5.9	85	56
6.0 - 6.9	85	71
7.0 - 7.9	84	79
8.0 - 8.9	91	78
9.0 - 9.9	93	100
10.0 - 10.9	91	57
11.0 - 11.9	92	0
12.0 - 12.9	91	0
13.0 - 13.9	67	0

Lambs weighing less than 4.0 pounds have no chance to survive under Fort Wingate conditions. The optimum rate of survival for both single and twin lambs occurs at a birth weight of 9.0 - 9.9 pounds, with the percentage of survival declining in both heavier and lighter lambs born single or twin. Survival rates for singles and twins follow a similar pattern, but the change in rate of survival between weight groups is more pronounced for twins. Single and twin lambs that survived weighed 0.42 and 0.86 pounds more at birth, respectively, than those which did not survive. For those ewes producing singles, the lamb survival rate increased through five years old dams, and then leveled off for six year olds. Ewes that are six years old or older can adequately care for a single lamb, but do not do as well with twin lambs.

HERDED VERSUS FENCED RANGES

A study of herded versus fenced ranges was undertaken at Fort Wingate. Gain in body weight of ram lambs from weanling to yearling ages (September to June) was used as a measure of the relative value of the two systems of management. In 1958 under herded conditions, 67 ram lambs made an average gain of 54.0 pounds, while in 1959 on fenced range, 73 ram lambs of similar breeding averaged 66.2 pounds gain. This is an advantage of 12.2 pounds of gain in favor of the lambs under fence. The ewe lambs (251 in 1958 and 248 in 1959) were herded both years and were used for comparative purposes. The 1959 ewe lambs gained only 1.7 pounds more than the 1958 ewes from September to June. Thus the differences that were found for the ram lambs were only slightly affected by early environmental differences, and can be largely attributed to the difference in management.

Project W-46: The Effects of Environmental Stresses on Range Cattle and Sheep Production

Influence of Environment at Different Geographic Locations on Fleece and Body Traits of Sheep.

This project was initiated in 1957 with 40 Rambouillet rams, born in 1955, from the genetically stabilized group at Dubois, Idaho. These were divided into eight approximately equal groups by randomizing within body weight classes. Two groups each were placed at Dubois, Idaho; University Park, New Mexico; Beltsville, Maryland; and Tifton, Georgia, in early March, 1957. One group of five rams at each location was individually fed with 5.4 pounds (10 percent moisture) daily of alfalfa pellets from a common source. The other group of five rams at each location was handled and fed with other flock rams at that location. This generally involved pasture or range except in winter, but those at New Mexico were fed in a dry lot the entire year. In May, 1959, all these rams were sold and another group of new rams born in 1957 were distributed to each of the four locations. Numerous body and fleece scores, measurements, and samples were taken when the rams were sheared in April-May in 1957, 1958, 1959 and 1960. Immediately after shearing in 1958 and 1960, 24 of the rams were transferred among locations so that one ram from each treatment at each location was sent to each other location for the second year and one or two rams from each treatment at each location were retained at that location for the second year.

The rams at New Mexico gained the most during the 1959-60 period, while during the 1957-58 period, the rams at Maryland gained the most. Weight gains were greater for the individual-fed rams than for the group-fed rams. Also, more variation was found between locations for the group-fed rams than for the individually-fed rams for all years.

Feed consumption per pound of gain was highest at Georgia and lowest at New Mexico. There was little difference in pounds of feed required per pound of wool produced at any of the locations.

Observations are being made on the histology of the skin, and the work to date shows a fairly uniform penetration of follicles in the skin at all locations. The wool follicles of the individually-fed rams tended to show slightly deeper penetration than the rams under pasture condition. This fact seems worth noting since the individually-fed rams also produced more clean wool than the group-fed rams. Final conclusions will be based on results from all four years of this study.

IMPROVEMENT OF NAVAJO SHEEP BY LINE BREEDING AND SELECTION WITHIN THE NAVAJO STRAIN

The Navajo sheep are important in this area because they have survived several centuries of virtually natural selection under arid southwestern conditions. They are therefore well adapted to this environment in their ability to live and reproduce under sparse feed conditions. Since there is no longer available any other source of Navajo sheep, it is important to preserve and improve these sheep for use in crossbreeding and for developing highly productive sheep adapted to this area.

Number of rams used, age at lambing, and body weight and fleece characteristics at yearling age are presented in Table 3. The data are averaged by five year periods from 1947 to 1956 and by years from 1957 to date.

TABLE 3. YEARLING TRAITS OF NAVAJO BREEDING RAMS

Year	No. of Rams	Age at Lambing (years)	Yearling Body Weight (lbs.)	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Grade	Staple Length (cms.)	Medullated Fibers (percent)
1947-51	20	3.1	112.7	7.13	4.62	48s	15.9	0.5
1952-56	22	3.0	105.9	5.56	3.44	54s	10.7	.4
1957	3	2.3	105.3	5.35	3.59	58s	12.0	.2
1958	3	2.0	93.0	4.57	2.78	64s	8.9	.0
1959	3	2.0	118.7	5.47	3.13	60s	10.2	.0
1960	3	2.0	122.3	5.50	3.35	58s	9.9	.1
1957-60	12	2.1		5.22	3.21	60s	10.2	.1

The rams used for breeding in both 1959 and 1960 were heavier bodied and produced greater amounts of both grease and clean wool that the average of all rams. Selection for freedom from medullated fibers resulted in selecting shorter staple rams in both years. The 1959 rams had fleeces that graded finer than average, while the rams used in 1960 had fleeces of average fineness.

CHARACTERISTICS OF NAVAJO BREEDING EWES

Yearling body weight, yearling fleece and fiber traits, and age at lambing are presented in Table 4 for the Navajo breeding ewes. These data are averaged by five year periods from 1947 to 1956, and by years from 1957 to date.

TABLE 4. CHARACTERISTICS OF NAVAJO BREEDING EWES AS YEARLINGS

Year	No. of Ewes	Age at Lambing (years)	18 Month Weight (lbs.)	Fleece Weight Grease (lbs.)	Fleece Weight Clean (lbs.)	Grade	Staple Length (cms.)	Kemp (percent)	Medullated Fibers (percent)
1947-51	660	5.5	99.7	5.27	3.44	58s	10.0	0.4	1.2
1952-56	582	4.8	97.2	5.05	2.92	58s	10.4	.1	1.2
1957	75	3.2	93.2	3.93	2.53	62s	9.6	.0	.02
1958	98	3.6	92.1	4.10	2.64	60s	9.4	.0	.02
1959	115	4.0	95.9	4.10	2.65	60s	9.4	.0	.02
1960	108	4.1	96.5	4.08	2.57	60s	9.1	.0	.05
1957-60	396	3.8	94.6	4.06	2.60	60s	9.4	.0	.03

The Navajo ewes selected for breeding in 1959 and 1960 were slightly older than those selected the preceding two years, but they were younger than the 1947 to 1956 averages. Decreasing body weights in recent years caused some concern, and it was decided to increase selection intensity for this trait. The result was that the 18 months weight of the ewes bred in 1959 and 1960 averaged 3.6 pounds heavier than those for 1957 and 1958.

Staple length has shown a steady decrease in length since 1955, and represents selection against the coarser and longer outercoat fibers. Also since 1955, the breeding ewes have had fleeces that averaged less than one tenth of one percent kemp. For the two years 1959 and 1960, there was only one ewe (in 1960) that had any kemp fibers. The percentage of medullated fibers increased slightly in 1960 over the previous three years. This is probably due in part to relaxed selective pressure for this trait which accompanied the increased selection for body weight.

LAMB PRODUCTION OF NAVAJO MATINGS

Lamb production in the Navajo line is summarized in Table 5. For the years 1937 through 1951, the percentage of ewes lambing was based on the number of ewes bred, but from 1952 to date, it is based on the numbers of ewes bred and still in the flock at lambing time. In this way the percentage of ewes lambing is an indication of fertility that is not confounded with past breeding death losses. The figure is affected by the fertility of both rams and ewes. The percentage of lambs born of ewes lambing is based on all lambs born, whether dead or alive, of those ewes actually having lambs. This value minus 100 gives the percentage of ewes having twins. The percentage of lambs weaned of live lambs born is a measure of lamb survival from birth to weaning, and the percentage of lambs weaned of ewes bred is a combination of the first three values plus any effects of ewe loss after weaning. The average weaning weights for the years 1937 through 1946 are unadjusted for any measurable environmental effects, and represent a growth period of about 140 days. Beginning in 1947, the weaning weights are adjusted to a constant age of 120 days and are corrected for type of birth and rearing of the lamb and age of the dam.

The percentage of ewes lambing has remained constant the past four years, and is higher than the previous 20 year average. The average weaning weight of 60.6 pounds in 1960 is the third highest recorded since the line was established in 1937. It is exceeded only by 1943 and 1941 when average weights of 61.5 and 63.4 pounds, respectively, were achieved. However, the weights for 1943 and 1941 were not adjusted for environmental effects, so the data are not strictly comparable. Pounds of lamb weaned per ewe bred was also above average in 1960, and is the highest recorded since 1953.

TABLE 5. LAMB PRODUCTION OF NAVAJO MATINGS

Year	No. of Ewes Bred	Percent[a] of Ewes Lambing	Percent Lambs Born of Ewes Lambing	Percent Lambs Weaned of Ewes Bred	Percent Lambs Weaned of Lambs Born Alive	Average Weaning Weight (lbs.)	Pounds of Lamb per Ewe Bred
1937 - 41	1745	88.3	125.2	97.3	92.5	57.0	55.4
1942 - 46	852	88.6	148.2	109.7	84.4	58.1	63.8
1947 - 51 [b]	660	80.8	136.8	79.8	72.7	48.8	43.3
1952 - 56	580	90.0	127.0	100.9	92.9	54.8	55.2
1957	76	93.2	114.5	102.6	98.7	58.9	59.7
1958	98	93.7	138.2	106.1	85.2	51.2	53.8
1959	115	93.8	128.3	109.6	94.0	52.8	57.9
1960	108	95.4	120.4	102.8	91.0	61.1	62.8

a/ Percent of ewes lambing of ewes bred for the years 1937 - 1951, but percent of ewes lambing of ewes bred and present at lambing for years 1952 - 1960.

b/ The low values for percent of lambs weaned and average weaning weights for the 1947-1951 period is due partly to: (1) use of a sterile ram in 1950, and (2) severe death losses of ewes and lambs due to a hail storm in 1951.

NAVAJO WEANLING LAMBS

Fleece and body traits of Navajo weanling lambs are presented in Tables 6 and 7. Weanling lambs are scored by a committee of three Animal Husbandmen at weaning time, in September. Weaning weights and the average committee scores for type and condition are adjusted to a constant age of 120 days, and for the effects of age of dam and type of birth and rearing of the lamb. Face covering scores are not adjusted. Scoring may vary slightly from year to year, because the committee members are not always the same. The scores taken in any one year, however, can be used to compare different groups of lambs, since all lambs are scored by the same committee in any one year.

Very little change can be noted in any of these traits. Weaning weights and condition scores are dependent largely on the environment of each particular year, and on the rate of twinning - twin lambs being particulary hard hit in years of poor feed conditions. The years 1958 and 1959 are above average for rate of twinning, but are poorer than average in weaning weight and condition score. Navajo lambs are uniformly poor in type, having a thin and upstanding conformation. They are slow to fatten externally, but store considerable amounts of visceral fat.

For the years 1952 to 1960, ram lambs have averaged 5.9 pounds heavier than ewe lambs. The difference varied from 2.3 pounds in 1952 to 7.9 pounds in 1957. Sex differences for the other traits are not so marked nor consistent. Face covering scores have varied the least of all. The typical Navajo lamb is well open-faced, and seldom has wool below the eyes. Once adequate vision is established (a score of 3.0 or better) there is no selective advantage to increased open-facedness.

Staple length has been adjusted to a constant age of 120 days for all years shown. Although rigid selection has been practiced against kemp and medullated fibers, a small number of lambs are encountered each year that have an appreciable number of these objectionable fibers.

TABLE 6. FACE AND BODY TRAITS OF NAVAJO WEANLING LAMBS

Year	Sex	No. of Lambs Weaned	Weaning Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score
1952-56	Rams	312	57.09	3.27	3.40	2.33	1.71
	Ewes	276	52.22	3.14	3.22	2.30	1.96
1957	Rams	38	63.08	3.11	3.15	2.22	1.56
	Ewes	40	55.20	2.94	2.81	2.49	2.08
1958	Rams	45	55.49	3.23	3.84	2.44	1.61
	Ewes	60	49.50	3.31	3.84	2.43	2.02
1959	Rams	65	55.50	3.65	4.40	2.08	1.65
	Ewes	61	50.15	3.68	4.33	2.24	1.90
1960	Rams	61	63.72	3.42	3.58	2.21	1.79
	Ewes	50	56.84	3.59	3.69	2.21	1.66

TABLE 7. FLEECE CHARACTERISTICS OF NAVAJO WEANLING LAMBS

Year	Sex	No. of Lambs Weaned	Fiber Traits at Side: Staple Length (cms.)	Fiber Diameter (microns)	Medullated Fibers (percent)	Kemp Fibers (percent)	Outer-coat Score
1952-56	Rams	312	5.21	28.0	2.40	.34	2.51
	Ewes	276	5.19	28.8	3.13	.56	2.86
1957	Rams	38	4.57	27.6	.32	.00	2.30
	Ewes	40	5.08	28.5	.67	.00	2.50
1958	Rams	45	5.07	27.2	.81	.12	1.59
	Ewes	60	5.13	27.7	.21	.04	1.69
1959	Rams	65	5.95	28.8	.55	.04	2.00
	Ewes	61	5.77	29.5	.72	.05	1.92
1960	Rams	61	5.11	28.5	.25	.00	1.31
	Ewes	50	5.64	30.1	.70	.03	1.54

SELECTION OF NAVAJO WEANLING LAMBS

Selection differentials, relative emphasis placed on each trait, and the expected genetic gains per generation for the Navajo weanling lambs for the years 1959 and 1960 are reported in Table 8. The selection differential is the difference between the average of the selected lambs and the average of all lambs from which they were selected. The relative emphasis placed on each trait is obtained by dividing the selection differential by the standard deviation. The expected genetic gain per generation, when selection is practiced in one sex, is one-half the heritability times the selection differential. When selection is practiced in both sexes, the expected genetic gain per generation is the sum of the values of both sexes.

For those traits measured by scores, the signs have been reversed, so that the selection differentials indicated how much better (positive) or poorer (negative) the average of the selected lambs were than the average of all lambs weaned. For those traits measured quantitatively (weaning weight, staple length, fiber diameter), the signs remain untouched, so that a positive selection differential indicates that the average of the selected lambs was greater than the average of all lambs weaned.

Among the 1959 ram lambs, the greatest emphasis was placed on fiber diameter and color score. Condition and outercoat scores received the greatest emphasis in the 1959 ewe lambs. In 1960 the greatest emphasis was placed on weight in the ram lambs and staple length in the ewe lambs. The negative selection differentials for staple length in both years is desirable in this breed of sheep, and indicates selection against the long, shaggy fleeces that are high in outercoat, kemp and medullated fibers.

TABLE 8. SELECTION PRACTICED ON NAVAJO WEANLING LAMBS

Year	Sex		Weaning Weight (lbs.)	Body Type Score	Condition Score	Face Covering Score	Staple Length (cms.)	Fiber Diameter (microns)	Outer-coat Score	Color Score	Percent Saved
		Heritabilities	.21	.04	.11	.46*	.06	.30	-	-	
1959	Rams	Selection Differentials	2.14	.15	.13	- .006	- .11	1.56	.14	.48	18.5
		Relative Emphasis	.340	.420	.250	- .017	- .090	.745	.249	.518	
		Expected Genetic Gain	.225	.003	.007	- .001	- .003	.234			
	Ewes	Selection Differentials	1.65	.08	.22	.07	- .11	.45	.21	.18	59.0
		Relative Emphasis	.273	.180	.372	.146	- .129	.176	.364	.170	
		Expected Genetic Gain	.173	.002	.012	.016	- .003	.068			
1960	Rams	Selection Differentials	6.08	.11	.06	.28	- .33	.28	.00	- .32	14.8
		Relative Emphasis	.827	.268	.163	.499	- .232	.115	.00	- .373	
		Expected Genetic Gain	.638	.002	.003	.064	- .010	.042			
	Ewes	Selection Differentials	1.02	.05	.10	.00	- .47	- .22	.15	.16	64.0
		Relative Emphasis	.166	.125	.205	.00	- .268	- .109	.301	.170	
		Expected Genetic Gain	.107	.001	.006	.00	- .14	- .033			

* Heritability estimate for face covering score obtained for range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho.

YEARLING NAVAJO TRAITS

Characteristics of Navajo yearling rams and ewes are presented in Tables 9 and 10. Body weights and type and condition scores are taken in June when the sheep are approximately 400 days of age, while the other scores and measurements are taken in April, a few days before shearing. From 1947 to 1956 inclusive, clean fleece weights were estimated by scouring small samples of wool taken from the middle of the left side. Beginning in 1957, the clean fleece weights have been estimated by means of the Neale fleece squeeze machine. Data on the rams have not been adjusted for any environmental factors. In the ewe data, body weight, type score, conditon score, staple length, and grease and clean fleece weights are adjusted for age of dam and type of birth and rearing. In addition, body weight is adjusted to a constant age of 400 days, while staple length and fleece weights are corrected to a constant age of 365 days.

Body weights for both rams and ewes in 1960 were the heaviest recorded; however, type and condition scores are only average. Clean fleece weights were heavier in 1960 than any time in the past ten years. Staple length was longer and fiber diameter coarser in 1960 than in recent years. Conversely, outercoat scores and percentage of medullated fibers were poorer in 1960 than in the previous three years.

In recent years, the Navajo sheep have been becoming smaller in size, and they have been producing a fleece that was shorter, finer, and lighter in weight than is desirable. Much of this was probably the result of intensive efforts to remove kemp and medullated fibers from the breed. With the switch in emphasis to body size, fleece weight, and a coarser fiber more suitable for hand weaving, there has been some concomitant increase in medullation. It is hoped that the percentage of medullation can be held at its present level while further increases are made in body size and fleece weight.

TABLE 9. BODY WEIGHTS AND SCORES OF NAVAJO YEARLING SHEEP

Year	No. of Sheep	Body Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score
			YEARLING RAMS			
1947-51	41	106.0	2.93	2.90	2.43	1.29
1952-56	41	103.1	3.13	3.06	1.57	1.17
1957	11	94.5	3.12	3.55	1.89	1.00
1958	13	112.9	3.66	3.60	1.88	1.38
1959	14	108.9	3.61	3.44	2.06	1.36
1960	11	119.7	2.98	2.73	1.43	1.27
			YEARLING EWES			
1947-51	241	53.6*	2.96	2.81	2.40	1.65
1952-56	129	70.9	3.12	3.13	1.77	1.62
1957	26	85.3	3.11	3.33	2.10	1.46
1958	30	80.5	3.67	3.81	2.07	1.54
1959	37	82.9	3.30	3.00	2.75	1.59
1960	36	89.4	3.25	3.19	1.53	1.67

* The 1947-1951 average is pulled down below normal by the extremely poor year of 1951.

TABLE 10. FLEECE CHARACTERISTICS OF NAVAJO YEARLING SHEEP

Year	No.of Sheep	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Staple Length (cms.)	Outer-coat Score*	Medullated Fibers Percent
			YEARLING RAMS				
1947-51	41	6.40	3.95	29.6	12.8	2.56	.67
1952-56	41	4.84	3.06	26.1	9.6	1.93	.03
1957	11	4.55	2.85	23.8	9.3	1.00	.00
1958	13	4.86	2.98	25.5	10.5	1.38	.06
1959	14	5.08	3.06	25.7	10.2	1.19	.16
1960	11	5.66	3.36	31.0	12.4	2.45	.07
			YEARLING EWES				
1947-51	241	5.64	3.51	27.1	11.4	3.13	1.91
1952-56	129	4.27	2.69	24.7	9.8	2.94	.33
1957	26	4.27	2.76	26.3	9.2	1.87	.02
1958	30	4.32	2.78	26.3	8.7	1.62	.00
1959	37	4.76	2.88	24.2	9.0	1.67	.11
1960	36	5.58	3.33	30.5	11.0	1.86	.23

* Scores for outercoat not taken prior to 1949.

IMPROVEMENT OF FINE WOOL SHEEP UNDER SOUTHWESTERN CONDITIONS

The objective of this project is to test the adaptability and usefulness of Targhee and other breeds of fine wool sheep under southwestern conditions, and to evaluate and demonstrate fine wool sheep improvement practices to Navajo sheep producers. Production of wool and lambs by Navajo stockmen has generally been lower than the average produced by commercial stockmen in New Mexico and Arizona. It is estimated that about 10 percent of the total reservation wool production is used for hand manufacture of rugs, while the remaining 90 percent is sold on the domestic market, often at an appreciable discount due to inferior quality. Crosses of Targhee rams on Navajo and Navajo crossbred ewes have shown improvement in both quality and quantity of lamb and wool produced. It is important to determine if these gains can be maintained by purebred Targhee sheep. Furthermore, it is essential to demonstrate to Navajo stockmen the procedures to be followed and the gains to be made from using improved sires in a consistent breeding program.

Three distinct lines of breeding are included in this project. Breeding group 13 was developed by mating Targhee rams to Navajo crossbred ewes. Breeding groups 20, 21, and 22 are composed of average Navajo reservation ewes mated to average reservation rams, Rambouillet rams obtained from the Navajo Tribal Ram Pasture enterprise, and purebred Targhee rams, respectively. Group 25 is a pure line of Targhee sheep. Emphasis in this project is placed on staple length, fineness, clean fleece weight, freedom from kemp and medullated fibers, adaptability, and lamb production. As a result of selecting for the above traits, it is hoped to develop an animal that will produce a miximum amount of wool of a suitable quality and lambs that will meet the requirements of feed lot operations. The combination of these factors should produce a maximum return on sheep investments.

The characteristics of the finewool rams used for breeding in 1959 and 1960 are presented in Table 11. It is interesting to note that the crossbred Targhee rams in group 13 were heavier at yearling age than all other rams, although the purebred Targhee rams of groups 22 and 25 will average from 20 to 50 pounds heavier than the crossbreds at mature ages. Group 20 is the control group, and shows only slight differences between years.

Table 11. Characteristics of Finewool Breeding Rams

Year and Breeding Group No.	No. of Rams	Age at Lambing (years)	Yearling Body Wt. (lbs.)	Yearling Fleece Weights Grease (lbs.)	Yearling Fleece Weights Clean (lbs.)	Yearling Fiber Traits, Side Staple Length (cms.)	Yearling Fiber Traits, Side Fiber Diameter (microns)	U.S. Grade
1959								
Group 13	3	2.0	129.3	7.95	4.16	9.4	22.6	62's
20	10	2.0	110.0	5.60	2.84	5.0	19.9	70's
21	10							
22	10	3.1	116.0	9.04	4.36	8.1	20.6	70's
25	6	3.0	118.4	12.80	6.25	9.5	23.7	62's
1960								
Group 13	3	2.3	127.0	7.87	3.79	9.4	22.6	62's
20	10	2.0	103.1	4.84	2.41	4.9	20.8	70's
21	10							
22	10	3.9	111.3	10.99	5.34	9.2	22.4	64's
25	6	3.8	108.2	10.20	4.90	9.4	22.4	64's

Rams used in group 21 were obtained from a private breeder, so yearling records are not available.

Characteristics of the finewool breeding ewes are presented in Table 12. Inasmuch as the majority of the ewes were bred in both 1959 and 1960, there is very little difference in the averages for these two years. Since 1955 however, there has been a gradual increase in 18 months body weight, grease fleece and clean fleece weights, and staple length. Wool fineness has remained practically constant however, while medullated fibers have been reduced to approximately 0.01 percent and are no longer reported.

Of the five breeding groups, line 13 has the longest and coarsest fibers and heaviest fleece weights, while line 20, which is the unselected group, has the shortest staple and lightest fleece and body weights. The purebred Targhees (line 25) have the heaviest body weights. Average age of the breeding ewes has also increased due to the necessity of keeping the foundation ewes in the flock during these early years of this project.

Table 12. Characteristics of Finewool Breeding Ewes.

Year and Breeding Group No.	No. of Ewes	Age at Lambing (years)	18 Mos. Body Wt. (lbs.)	Yearling Fleece Weights Grease (lbs.)	Yearling Fleece Weights Clean (lbs.)	Yearling Fiber Traits, Side Staple Length (cms.)	Yearling Fiber Traits, Side Fiber Diameter (microns)	U. S. Grade
1959								
Group 13	112	4.0	103.6	6.08	3.01	8.1	21.1	64's
20	112	3.7	97.7	5.32	2.38	5.3	19.9	70's
21	113	4.0	98.3	5.76	2.57	6.3	19.1	80's
22	105	4.0	101.8	5.58	2.62	6.1	20.0	70's
25	68	4.1	111.0	6.01	2.93	7.0	19.3	80's
1960								
Group 13	116	4.0	102.7	6.14	2.98	8.3	21.4	64's
20	122	3.8	96.3	5.33	2.39	5.4	19.9	70's
21	110	4.0	99.0	6.02	2.61	6.5	19.0	80's
22	117	3.9	103.5	5.81	2.75	6.4	20.0	70's
25	73	4.1	109.4	6.02	2.85	7.1	19.3	80's
Totals and Averages								
1955	431	3.4	96.3	5.19	2.14	6.1	-	70's
1956	432	3.4	97.4	5.00	2.11	5.8	-	70's
1957	373	3.9	102.5	5.08	2.25	6.1	-	70's
1958	483	3.5	101.4	5.54	2.52	6.4	-	70's
1959	510	3.9	101.7	5.73	2.68	6.5	19.9	70's
1960	538	3.9	101.6	5.84	2.70	6.7	20.0	70's

Table 13 summarizes the lamb production of the five lines of finewool breeding ewes. The percentage of ewes lambing is based on the number bred and still present at lambing time. Percentage of lambs born includes all lambs, whether dead or alive, that were born. This figure minus 100 gives the percentage of twinning. The percentage of lambs weaned of lambs born alive indicates the rate of lamb survival from birth to weaning.

Lamb production in 1959 was only slightly different from the 1955 - 1960 average for all traits measured. However, 1960, in spite of the lack of rainfall, was one of the best years on record. New high values were established for all traits except percentage of lambs born, and percentage of ewes lambing. The percentage of lambs born was the second highest on record and well above the 1955-1960 average, while the percentage of ewes lambing was approximately equal to the six year average. Among the five breeding lines, the only readily apparent trend is that line 25, the purebred Targhees, still lack hardiness and adaptability to this environment as indicated by the low degree of fertility (percent of ewes lambing) and high lamb mortality (percent lambs weaned of lambs born alive).

Table 13. Lamb Production of Finewool Matings.

Year and Breeding Group No.	No. of Ewes Bred	Percent of Ewes Lambing	Percent Lambs Born of Ewes Lambing	Average Birth Weight (lbs.)	Percent Lambs Weaned of: Ewes Bred	Percent Lambs Weaned of: Lambs Born Alive	Average Weaning Weight (lbs.)	Pounds of Lamb per Ewe Bred
1959								
Group 13	112	94.3	118.0	8.7	83.0	80.9	56.9	47.2
20	111	82.0	116.5	8.6	86.5	90.6	55.0	47.6
21	113	92.9	109.6	8.8	80.5	80.5	57.7	46.5
22	105	90.4	120.2	9.0	86.7	80.5	61.1	52.9
25	68	83.8	121.1	8.8	63.2	62.3	56.8	35.9
1960								
Group 13	116	89.6	118.4	10.2	98.3	95.0	71.1	69.8
20	122	90.2	125.5	9.4	103.3	91.3	64.5	66.6
21	110	94.5	114.6	10.0	100.0	93.2	68.7	68.7
22	117	83.8	131.6	9.9	104.3	94.6	67.4	70.3
25	73	78.9	119.6	9.9	68.5	83.3	69.7	47.8
Totals and Averages								
1955	431	82.8	105.1	7.9	60.0	68.1	54.5	32.5
1956	432	89.1	107.0	9.0	82.4	86.6	63.0	51.8
1957	373	91.6	106.9	8.9	86.4	90.8	63.3	54.6
1958	483	89.5	125.5	8.0	73.7	72.1	53.4	39.3
1959	509	89.0	116.6	8.8	81.3	80.2	57.6	46.8
1960	538	88.0	122.1	9.9	97.0	92.4	68.0	66.0

FINEWOOL WEANLING LAMBS

Characteristics of the finewool weanling lambs are presented in Tables 14 and 15. Weaning weight and type and condition scores have been adjusted to a constant age of 120 days and for the effects of age of dam and type of birth and rearing. Staple length has been adjusted to a constant age of 120 days.

Ram lambs averaged 6.0 pounds heavier in 1959 and 6.6 pounds heavier in 1960 than ewe lambs, and were slightly better than the ewes in type, condition and color scores. Ewe lambs, on the other hand, had slightly better face scores, and had longer and coarser wool than the ram lambs. Ewe lambs also had slightly more kemp and medullated fibers than the rams.

Ram and ewe lambs averaged 12.4 and 11.8 pounds heavier, respectively, in 1960 than in 1959. Type scores were one-third of a grade better in 1960 than in 1959, while the 1960 condition scores averaged nearly a full grade better than those in 1959. Face and outercoat scores and the percentage of medullated fibers were also slightly improved in 1960 over the previous year. Weanling fleece averaged about one cm. shorter, but one micron coarser in 1960 than in 1959. Color scores and the percentage of kemp fibers were slightly poorer in 1960 than in 1959.

Group 13 lambs had the longest staple, coarsest fibers and best face covering score in both sexes for both years. In most cases they also had the highest percentage of kemp and medullated fibers and the poorest outercoat scores. However, in 1960, the lambs in group 13 were superior for weaning weight and type score, and were second best in condition score. The group 20 lambs (the control group) were the poorest for weaning weight, staple length, and type, condition, and color scores. Lambs in group 21 had the finest and most uniform fleeces, but they also had the greatest amount of face covering. On a within sex within year basis, the ewe lambs in this group seemed to rank higher than the rams for weight, type and condition. The lambs in group 22 were above average in weight, type and condition, and were, in fact, top in these traits for 1959. These lambs have good staple length, and are generally exceeded in this trait only by group 13. The pure-bred Targhee lambs (group 25) were near average for most traits. The greatest weakness of this line is its lack of hardiness or adaptability to southwestern conditions as evidenced by the low rate of survival and small numbers of lambs weaned. In 1960 it was necessary to save 86 percent of the ram lambs and 95 percent of the ewe lambs. Progress in group 25 will necessarily be slow until such time as numbers and survival rate are sufficient to allow for a greater intensity of selection.

TABLE 14. FACE AND BODY TRAITS OF FINEWOOL WEANLING LAMBS

Year and Breeding Group No.	Sex	No. of Lambs	Weaning Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score
1959							
Group 13	Rams	38	59.1	3.22	3.87	2.77	1.11
20		45	57.1	3.51	4.00	3.25	1.33
21		42	58.8	3.35	4.06	3.47	1.02
22		50	62.9	3.08	3.62	3.12	1.00
25		19	59.5	3.35	4.10	2.88	1.00
13	Ewes	52	52.9	3.30	3.86	2.68	1.10
20		50	52.2	3.55	4.08	3.01	1.52
21		49	53.7	3.45	4.02	3.27	1.02
22		41	56.2	3.27	3.82	2.95	1.02
25		24	53.4	3.29	4.02	2.85	1.13
1960							
Group 13	Rams	52	74.4	2.66	2.93	2.72	1.04
20		62	69.5	3.29	3.21	3.26	1.89
21		67	71.7	3.05	3.15	3.52	1.09
22		61	72.0	2.82	2.95	2.92	1.00
25		29	73.9	2.67	2.79	2.66	1.03
13	Ewes	61	67.4	2.79	2.92	2.59	1.05
20		61	62.9	3.50	3.32	2.97	2.13
21		42	65.1	3.11	3.13	3.17	1.07
22		58	66.7	2.83	2.88	2.68	1.12
25		21	63.8	2.91	2.99	2.71	1.05
Totals & Averages							
1959	Rams	194	59.6	3.29	3.90	3.13	1.10
	Ewes	216	53.6	3.38	3.96	2.96	1.17
1960	Rams	271	72.0	2.94	3.04	3.08	1.24
	Ewes	243	65.4	3.04	3.05	2.82	1.34

TABLE 15. FLEECE CHARACTERISTICS OF FINEWOOL WEANLING LAMBS

Year and Breeding Group No.	Sex	No. of Lambs	Fiber Traits at Side: Staple Length (cms.)	Fiber Diameter (microns)	Medullated Fibers (percent)	Kemp Fibers (percent)	Outer-coat (score)
1959							
Group 13	Rams.	38	5.01	25.01	.27	.00	1.11
20		45	3.06	23.22	.06	.00	1.10
21		42	3.84	22.54	.03	.00	1.03
22		50	3.97	23.59	.04	.00	1.00
25		19	3.38	22.09	.02	.00	1.05
13	Ewes	52	5.60	26.41	.08	.00	1.09
20		50	3.04	23.84	.28	.00	1.06
21		49	4.35	23.01	.06	.00	1.01
22		41	4.08	24.22	.04	.00	1.01
25		24	3.92	23.21	.02	.00	1.00
1960							
Group 13	Rams	52	3.75	25.60	.15	.03	1.00
20		62	2.12	25.30	.03	.00	1.02
21		67	2.80	22.20	.00	.00	1.00
22		61	3.28	24.87	.04	.00	1.00
25		29	2.97	24.64	.01	.01	1.00
13	Ewes	61	3.96	26.20	.40	.09	1.04
20		61	2.13	25.21	.01	.01	1.00
21		42	3.10	23.32	.00	.00	1.00
22		58	3.72	25.62	.02	.00	1.01
25		21	3.06	24.92	.04	.00	1.00
Totals & Averages							
1959	Rams	194	3.88	23.41	.09	.00	1.06
	Ewes	2[illegible]6	4.25	24.27	.11	.00	1.04
1960	Rams	271	2.95	24.42	.05	.01	1.00
	Ewes	243	3.22	25.19	.11	.03	1.01

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS

Selection differentials, the relative emphasis placed on each trait, and the expected genetic gains per generation are summarized in Table 16. The selection differentials represent the average differences between the selected lambs and all lambs weaned after corrections for environmental influences have been made. Positive selection differentials for weaning weight are highly desirable and indicate selection of animals above average for this trait. With staple length, a positive selection differential is normally desirable, however, in these lambs a negative value for staple length usually indicates selection against the longer, coarser, and shaggier fleeces. Negative selection differentials for fiber diameter indicates selection of animals with finer fleeces which is desirable. For all other traits, which are measured by the scoring method, the signs have been reversed so that a positive selection differential represents selection for the superior animals. The zero or very low selection differentials for color and outercoat scores indicate that the group is free or nearly free of these objectionable traits.

The relative emphasis placed on each trait, sometimes called the relative intensity of selection, is obtained by dividing the selection differential by the standard deviation.

The expected genetic gain per generation from selection in only one sex is the selection differential times one-half of the heritability. The sum of the products for both sexes gives the net expected genetic gain per generation from selection practiced at weanling age on both sexes. These are only tentative gains, however, because not all lambs saved at weaning will be permitted to produce offspring. This is especially true in the rams where considerable selection is practiced at later ages, but in the ewes most of the effective selection is made at weaning age.

All rams are culled in groups 21 and 22. Ewes saved from these groups are mated to rams obtained from other sources. The rams in group 20, the control group, are selected at random, and it is noted that the selection differentials are generally quite small. It could not be expected that random selection would give zero selection differentials for all traits. Over a period of years however, the positive selections should be more or less balanced by the negative selections. At present all ewe lambs in this group are saved. If necessary they are culled at random at yearling age. As soon as numbers permit however, the ewe lambs in group 20 will also be selected at random at weanling age.

Heritability estimates for all traits except face covering, color and outercoat scores were computed from the records of Navajo and Navajo crossbred lambs produced from 1947 to 1953, inclusive. They are applicable to the extent that they are still representative of the present sheep. The heritability estimate for face covering score is that obtained on range Targhee and Columbia lambs at the U. S. Sheep Experiment Station, Dubois, Idaho. Thus the estimate of the expected genetic gains per generation for face covering score is accurate only to the extent that the Dubois heritability estimate is representative of the lambs at this station. Heritabilities for color and outercoat scores have not been computed.

TABLE 16. SELECTION PRACTICED ON FINE WOOL WEANLING LAMBS

	Year	Sex	Breeding Group Number	Weaning Weight (lbs.)	Type Score	Condition Score	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering Score	Color Score	Outer-coat Score	Percent Saved
Heritability				21%	4%	11%	6%	30%	46%	-	-	
Selection Differentials	1959	Rams	13	7.30	.59	.60	- .30	1.64	.20	.11	.11	34.2
			20	.36	- .09	- .10	- .16	- .23	- .08	- .07	.00	33.3
			21	ALL RAMS CULLED								
			22	ALL RAMS CULLED								
			25	.33	.07	.01	.06	.07	.01	.00	- .01	84.2
		Ewes	13	.67	.02	.01	.00	.05	.05	.01	.02	88.5
			20	ALL EWES SAVED								
			21	1.34	.07	.06	- .05	- .37	.07	.02	.00	81.6
			22	1.41	.06	.07	.00	- .27	.06	.00	.00	85.4
			25	1.41	.03	.06	.02	.24	.03	.08	.00	91.7
	1960	Rams	13	4.35	.15	.12	- .12	.23	.15	- .01	.00	38.5
			20	- .08	- .01	.03	- .04	-1.04	.14	.16	.01	24.2
			21	ALL RAMS CULLED								
			22	ALL RAMS CULLED								
			25	2.82	.11	.06	.08	.24	.01	- .01	.00	86.2
		Ewes	13	.21	.03	.03	- .15	- .07	.03	.01	.03	76.7
			20	ALL EWES SAVED								
			21	1.18	.05	.05	.09	.01	.15	- .02	.00	76.2
			22	.82	.07	.07	.12	- .09	.04	.07	.00	70.7
			25	.69	.06	.04	.05	.11	.00	.05	.00	75.2

TABLE 16, CONT. SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS

	Year	Sex	Breeding Group Number	Weaning Weight (lbs.)	Type Score	Condition Score	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering Score	Color Score	Outer-coat Score
Relative Emphasis placed on each trait	1959	Rams	13	.722	.837	.820	- .358	.692	.438	.283	.345
			20	.044	- .163	- .136	- .248	- .136	- .125	- .116	.000
			25	.034	.141	.030	.106	.043	.025	.000	- .044
		Ewes	13	.108	.043	.016	.000	.024	.102	.028	.084
			21	.193	.135	.100	- .069	- .167	.148	.140	.000
			22	.178	.099	.089	.000	- .144	.142	.000	.000
			25	.186	.049	.091	.031	.121	.083	.178	.000
	1960	Rams	13	.550	.334	.338	- .164	.110	.308	- .052	.000
			20	- .010	- .025	.082	- .057	- .474	.208	.135	.078
			25	.259	.231	.166	.100	.140	.019	- .054	.000
		Ewes	13	.030	.073	.079	- .156	- .032	.073	.046	.216
			21	.178	.133	.120	.164	.006	.278	- .059	.000
			22	.119	.205	.227	.185	- .048	.069	.152	.000
			25	.057	.087	.066	.072	.053	.000	.229	.000

TABLE 16, CONT. SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS

	Year	Sex	Breeding Group Number	Weaning Weight (lbs.)	Type Score	Condition Score	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering Score
Expected Genetic Gain per Generation	1959	Rams	13	.766	.012	.033	.009	.246	.046
			20	.038	- .002	- .006	- .005	- .034	- .018
			25	.035	.001	.001	.002	.010	.002
		Ewes	13	.070	.000	.001	.000	.008	.012
			21	.141	.001	.003	- .002	- .056	.016
			22	.148	.001	.004	.000	- .040	.014
			25	.148	.001	.003	.001	.036	.007
	1960	Rams	13	.457	.003	.007	- .004	.034	.034
			20	- .008	.000	.002	- .001	- .156	.032
			25	.296	.002	.003	.002	.040	.002
		Ewes	13	.022	.001	.002	- .004	- .010	.007
			21	.124	.001	.003	.003	.002	.034
			22	.086	.001	.004	.004	- .014	.009
			25	.072	.001	.002	.002	.016	.000

FINEWOOL YEARLING EWES AND RAMS

Characteristics of the finewool yearling ewes and rams are presented in Tables 17 and 18. Body weights and type and condition scores were recorded in June at approximately 400 days of age. All other traits were measured in April at shearing time, or a few days before. Body weights have been adjusted to 400 days of age, while staple length and fleece weights have been corrected to 365 days of age. In addition, these traits in the ewes have also been adjusted for the effects of age of dam and type of birth and rearing. Correction factors for the yearling rams have not been determined.

Body weights and type, condition, and face scores were improved in 1960 over 1959, while both years were superior to recent previous averages. Fleece weights, both grease and clean, were also heavier in 1960 than in 1959. Staple length showed mixed changes, with some groups having longer staple in 1960, while the others were better in 1959. Fiber diameter was coarser in all groups in 1960 than in 1959, and is no doubt a greater reflection of improved nutrition than it is selection for coarser fleeces. Outercoat scores were slightly poorer in the rams and slightly improved in the ewes for 1960, as compared with 1959. The percentage of medullated fibers showed a slight increase in 1960, which is undesirable.

TABLE 17. BODY WEIGHTS AND SCORES OF FINEWOOL YEARLINGS

Year	Sex	Breeding Group Number	No. of Sheep	June Body Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score
1959	Rams	13	12	120.5	2.64	2.40	2.56	1.08
		20	15	103.3	3.43	2.90	3.14	1.73
		25	14	124.1	2.60	2.13	3.27	1.00
	Ewes	13	31	89.3	2.48	2.10	2.24	1.00
		20	40	84.9	2.94	2.66	2.67	1.73
		21	29	91.3	2.75	2.53	2.64	1.07
		22	36	93.8	2.44	2.23	2.35	1.39
		25	18	95.6	2.35	1.98	2.55	1.00
1960	Rams	13	13	135.0	1.83	1.52	2.05	1.00
		20	14	116.2	3.02	2.46	2.52	1.50
		25	11	137.2	1.64	1.45	2.47	1.18
	Ewes	13	45	89.5	2.58	2.50	1.61	1.09
		20	49	88.7	3.08	2.88	2.22	1.60
		21	39	94.8	2.73	2.64	2.77	1.00
		22	35	94.9	2.41	2.34	2.24	1.14
		25	20	94.7	2.30	2.39	1.95	1.00

TABLE 18. FLEECE CHARACTERISTICS OF FINEWOOL YEARLINGS

Year	Sex	Breeding Group Number	No. of Sheep	Fleece weights Grease (lbs.)	Fleece weights Clean (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Outer-coat Score	Percent Medulla-ated Fibers
1959	Rams	13	12	7.46	3.65	9.08	24.0	1.00	.00
		20	15	5.01	2.74	4.98	20.7	1.00	.00
		25	14	6.89	3.30	7.96	20.4	1.00	.00
	Ewes	13	31	6.25	2.61	9.03	21.7	1.08	.13
		20	40	5.23	2.14	5.34	20.4	1.14	.00
		21	29	6.30	2.50	6.72	19.2	1.03	.00
		22	36	6.13	2.75	6.67	20.1	1.02	.03
		25	18	5.97	2.66	7.40	19.3	1.06	.00
1960	Rams	13	13	8.50	4.01	9.68	26.8	1.05	.03
		20	14	6.08	2.86	5.49	23.0	1.07	.00
		25	11	7.54	3.36	6.38	23.5	1.00	.00
	Ewes	13	45	7.09	3.54	8.12	23.0	1.03	.03
		20	49	5.83	2.87	5.17	23.7	1.05	.01
		21	39	7.31	3.38	6.81	20.2	1.00	.00
		22	35	6.98	3.39	6.66	22.3	1.00	.15
		25	20	7.07	3.48	6.94	22.9	1.00	.00

IMPROVEMENT OF COARSE WOOL SHEEP FOR THE PRODUCTION OF WOOL SUITABLE FOR NAVAJO HAND WEAVING

The objectives of this project are to develop and improve crossbred sheep producing quarter, or low quarter blood wool, suitable for Navajo hand weaving, which are adapted to southwestern ranges, and to provide a source of rams for Navajo producers of weaving wool. Part of the wool produced by Navajos is woven into rugs and blankets, which adds to their rather meager income. Consequently, production of wool suitable for hand weaving is still important to the Navajo economy. Emphasis has been placed on selecting breeding animals displaying hardiness, adaptability, body size, good staple length, and clean wool production.

TABLE 19. CHARACTERISTICS OF COARSEWOOL BREEDING RAMS, AS YEARLINGS

Year and Breeding Group No.	No. of Rams	Age at Lambing (years)	June Body Weight (lbs.)	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Medullated Fibers Percent
1959								
Group 16	4	2.0	130.0	6.64	3.70	10.7	28.6	.32
23	10	3.1	94.1	5.36	3.34	9.7	25.6	.00
1960								
Group 16	4	2.0	124.8	6.84	4.10	11.4	28.9	.00
23	10	3.3	102.7	5.44	3.22	10.4	27.0	.13
Totals & Averages								
1950-56	118	3.4	121.7	8.56	5.03	12.2	30.1	.03
1957	13	2.4	109.4	7.12	4.89	12.8	25.6	.00
1958	13	2.3	97.3	5.83	3.66	9.8	24.6	.00
1959	14	2.8	104.4	6.44	3.44	9.9	26.5	.09
1960	14	2.9	109.0	5.84	3.48	10.7	27.5	.09

COARSEWOOL BREEDING FLOCK

Characteristics of the coarsewool rams and ewes that were used for breeding in the years 1959 and 1960 are presented in Tables 19 and 20. The rams that were used in groups 16 and 23 are of the same breeding, and were produced in group 16. The procedure has been to select the four phenotypically best yearling rams each fall for use in group 16. If these rams produce satisfactory progeny, they are used the following year in breeding group 23. The remainder of the ten sires used in group 23 are made up of the second choice yearling and mature rams from group 16. It is for these reasons that the rams used in group 16 will nearly always average a year younger and exceed in all traits those rams used in group 23.

The breeding ewes of group 23 are composed of average Navajo Reservation ewes obtained in 1953 or the offspring of these ewes mated to group 16 rams. At the present time the group 23 ewes are largely first and second crosses. In 1959 and 1960, the ewes in group 16 averaged about five pounds heavier at 18 months of age and produced from 1/2 to 3/4 pound more clean wool than the group 23 ewes. The group 16 ewes also had coarser and longer fleeces with a higher percentage of medullated fibers than those in group 23. Selection for larger bodied ewes has resulted in a small but steady increase in the 18 months body weight over the last four years.

TABLE 20. CHARACTERISTICS OF COARSEWOOL BREEDING EWES, AS YEARLINGS

Year and Breeding Group No.	No. of Ewes	Age at Lambing (years)	18 Mos. Body Weight (lbs.)	Fleece Weight Grease (lbs.)	Fleece Weight Clean (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Medullated Fibers Percent
1959								
Group 16	119	3.7	105.1	5.59	3.43	10.5	25.2	.34
23	111	4.1	100.1	5.12	2.71	7.0	22.3	.02
1960								
Group 16	123	4.1	106.0	5.59	3.33	10.5	25.1	.32
23	113	4.3	101.6	5.17	2.81	7.3	22.6	.03
Totals & Averages								
1950-56	2778	4.1	102.7	6.50	3.60	10.2	60s*	.55
1957	152	3.4	101.2	4.95	2.73	8.5	64s*	.13
1958	216	3.6	101.9	5.28	2.88	8.7	62s*	.02
1959	230	3.9	102.7	5.36	3.05	8.8	23.8	.19
1960	236	4.2	103.9	5.39	3.05	9.0	23.9	.18

* Fineness for prior years reported in U. S. Grades.

LAMB PRODUCTION OF COARSEWOOL MATINGS

Table 21 summarizes the lamb production of the coarsewool ewes for the years 1959 and 1960. For the period 1937 through 1951, the percent of ewes lambing is based on the number of ewes bred. beginning in 1952, it is based on the number of ewes bred and surviving to lambing time. The newer method of computation gives an indication of fertility that is not confounded with post-breeding death losses. However, this percentage is affected by the fertility of both rams and ewes. The percent of lambs born minus 100 gives the rate of twin births. The percent lambs weaned of live lambs born measures the survival rate of lambs from birth to weaning age. Average weaning weights and pounds of lamb weaned per ewe bred were based on weights taken at about 140 days of age and unadjusted for any measurable environmental factors. From 1947 to date, the weights are adjusted to a constant age of 120 days and are corrected for age of dam and type of birth and rearing.

Average weaning weights and pounds of lamb weaned per ewe bred were higher in 1960 than in any previous year on record. No definite trends can be determined for the other traits, nearly all of which are influenced to a considerable extent by yearly environmental differences.

TABLE 21. LAMB PRODUCTION OF COARSEWOOL MATINGS

Year and Breeding Group No.	No. of Ewes Bred	Percent of Ewes Lambing	Percent Lambs Born of Ewes Lambing	Average Birth Weight (lbs.)	Percent Lambs Weaned of: Ewes Bred	Percent Lambs Weaned of: Lambs Born Alive	Average Weaning Weight (lbs.)	Pounds of Lamb per Ewe Bred
1937-41	1216	88.3	126.0	-	97.1	88.8	59.9	58.2
1942-46	1794	79.8	140.6	-	89.4	81.3	59.4	53.1
1947-51	3864	79.4	129.0	-	76.6	76.2	57.9	44.3
1952-56	1822	89.4	115.0	-	81.0	84.3	60.1	48.6
1957	152	94.1	106.4	-	96.1	98.1	64.0	59.7
1958	215	90.7	116.1	-	74.3	70.2	55.6	42.6
1959								
Group 16	119	88.9	100.0	8.80	88.2	91.3	58.8	51.8
23	111	90.0	122.2	9.15	91.0	83.5	59.6	54.3
1960								
Group 16	123	93.3	116.1	10.00	96.7	92.2	72.3	69.9
23	113	89.4	121.8	9.88	108.0	99.2	69.6	75.1

COARSEWOOL WEANLING LAMBS

Fleece and body characteristics of the coarsewool weanling lambs are summarized in Tables 22 and 23. Weaning weights and type and condition scores are adjusted to a constant age of 120 days and for the effects of age of dam and type of birth and rearing. Staple length is corrected to a constant age of 120 days.

Weaning weight is considerably heavier in 1960 than in 1959, and in fact, 1960 is the best year on record for this trait. Body type and condition scores are also improved in 1960 over those of 1959. The scores recorded for these traits are the average of a committee of three trained animal husbandmen. Since these committees differ from year to year, the differences between years are not directly comparable. Within any one year however, the committee remains the same, and breeding group differences are directly comparable.

Face covering score, color score, and outercoat score are also slightly improved in 1960. These traits are now quite satisfactory, with only a few animals showing objectionable amounts of color or outercoat. Animals with face scores of 3.00 or less are adequately open-faced for all purposes.

Staple length was shorter in 1960, but at the same time the fibers were slightly coarser. This situation no doubt is the result of the simultaneous selection against the extremely long, shaggy fleece with a high content of outercoat fibers, and for a good quality quarter blood fleece. Stringent selection against the highly objectionable outercoat fibers has tended to result in the selection of lambs that produce fleeces too fine for the objectives of this project. It has been only within the past several years, with the considerably reduced incidence of outercoat fibers, that selection of lambs with true quarter-blood fleeces has been possible.

TABLE 22. FACE AND BODY TRAITS OF COARSEWOOL WEANLING LAMBS

Year and Breeding Group No.	Sex	No. of Lambs	Adjusted Weaning Weight (lbs.)	Adjusted Type Score	Adjusted Condition Score	Face Covering Score	Color Score
1959							
Group 16	Rams	55	59.0	3.22	3.87	2.77	1.11
23		54	60.4	3.19	3.82	2.90	1.57
16	Ewes	50	53.4	3.40	4.05	2.68	1.59
23		47	55.6	3.28	2.94	2.52	1.49
1960							
Group 16	Rams	57	74.0	2.84	3.13	2.58	1.44
23		66	73.5	2.78	3.05	2.57	1.27
16	Ewes	60	67.6	2.84	3.13	2.58	1.44
23		55	65.0	2.90	3.13	2.53	1.33

TABLE 23. FLEECE CHARACTERISTICS OF COARSEWOOL WEANLING LAMBS

Year and Breeding Group No.	Sex	No. of Lambs	Fiber Traits at Side: Staple Length (cms.)	Fiber Diameter (microns)	Medullated Fibers (percent)	Kemp Fibers (percent)	Outer-coat Score
1959							
Group 16	Rams	55	6.68	30.2	2.97	0.15	1.60
23		54	5.41	27.7	.83	.00	1.12
16	Ewes	50	7.38	31.5	3.09	.28	1.67
23		47	6.14	31.1	.91	.00	1.36
1960							
Group 16	Rams	57	4.74	31.0	.14	.00	1.21
23		66	3.92	28.8	.34	.02	1.08
16	Ewes	60	5.67	33.2	.23	.01	1.42
23		55	4.40	29.6	1.28	.00	1.19

SELECTION OF COARSEWOOL WEANLING LAMBS

Selection differentials, the relative emphasis placed on each trait, and the expected genetic gains per generation are presented in Table 24. As noted for the previous sections: the selection differential is the difference between the average of the saved lambs and the average of all lambs from which they were selected; the relative emphasis is the ratio of the selection differential to the standard deviation; and the expected genetic gain per generation in one sex is one-half the heritability times the selection differential. Where selection is practiced in both sexes, the expected genetic gain per generation is the sum of the values of the two sexes. Naturally these are only tentative gains, since all animals selected will not produce offspring.

For all traits that are measured by means of scores, the signs have been reversed so that a positive value indicates improvement for that trait. In the other traits which are measured quantatively (weaning weight, staple length, and fiber diameter), the signs are untouched, so that a positive value means an increase in the unit of measurement for that trait. Greatest emphasis has been placed on weaning weight, type, condition and outercoat scores. Since only about one-third of the ram lambs are saved each year, it has been possible to exert greater selection pressure on them than on the ewe lambs, where two thirds or more are saved each year.

TABLE 24. SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS

	Year	Sex	Breeding Group Number	Weaning Weight (lbs.)	Type Score	Condition Score	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering Score	Color Score	Outer-coat Score	Percent Saved
Heritability				21%	4%	11%	6%	30%	46%			
Selection Differentials	1959	Rams	16	5.80	.30	.23	.12	.18	.21	.20	.31	30.9
			23			ALL RAMS CULLED						
		Ewes	16	2.30	.13	.14	- .02	.15	.10	.03	.25	65.3
			23	.79	.09	.06	- .35	.12	.03	.10	.08	76.6
	1960	Rams	16	6.65	.22	.18	.29	.44	.04	.29	.16	35.1
			23			ALL RAMS CULLED						
		Ewes	16	2.33	.10	.10	- .12	.19	- .06	.11	.08	63.3
			23	2.22	.09	.10	- .18	.22	.04	- .13	.08	63.6
Relative Emphasis	1959	Rams	16	.619	.552	.369	.093	.067	.404	.302	.546	
		Ewes	16	.296	.218	.197	- .012	.055	.184	.035	.322	
			23	.108	.181	.106	- .210	.039	.066	.108	.122	
	1960	Rams	16	.689	.437	.416	.220	.175	.064	.352	.425	
		Ewes	16	.311	.220	.243	- .076	.083	- .136	.133	.165	
			23	.253	.167	.220	- .123	.108	.067	- .180	.194	

TABLE 24, CONT. SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS

	Year	Sex	Breeding Group Number	Weaning Weight (lbs.)	Type Score	Condition Score	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering Score
Expected Genetic Gain per Generation	1959	Rams	16	.609	.006	.013	.004	.027	.048
		Ewes	16	.242	.003	.008	- .001	.022	.023
			23	.083	.002	.003	- .010	.018	.007
	1960	Rams	16	.698	.004	.010	.009	.066	.009
		Ewes	16	.245	.002	.006	- .004	.028	- .014
			23	.233	.002	.006	- .005	.033	.009

COARSEWOOL YEARLING TRAITS

Fleece and body characteristics of the coarsewool yearling rams and ewes are shown in Tables 25 and 26. June body weight and type and condition scores are greatly improved in the yearling rams in 1960, but are only slightly better in the ewes. Clean fleece weights are also considerably improved in 1960 in both sexes, with the group 23 ewes showing the greatest gain (.77 pounds). Face covering, color, and outercoat scores show fair to good gains in 1960. Only in the case of the group 16 rams did outercoat scores deteriorate. Fiber diameter was coarser in 1960, but staple length remained virtually unchanged. The percentage of medullated fibers increased in both rams and ewes of group 16, which is undesirable.

TABLE 25. BODY WEIGHTS AND SCORES OF COARSEWOOL YEARLINGS

Year	Sex	Breeding Group Number	No. of Sheep	June Body Weight (lbs.)	Type Score	Condition Score	Face Covering Score	Color Score
1959	Rams	16	13	111.7	2.82	3.06	2.50	1.46
	Ewes	16	30	89.9	2.93	2.76	2.07	1.63
		23	28	90.7	2.79	2.43	2.10	1.71
1960	Rams	16	15	139.6	1.90	1.92	1.68	1.27
	Ewes	16	32	91.8	2.66	2.60	1.49	1.47
		23	35	95.9	2.67	2.71	1.64	1.49

TABLE 26. FLEECE CHARACTERISTICS OF COARSEWOOL YEARLINGS

Year	Sex	Breeding Group Number	No. of Sheep	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Outer-coat Score	Percent Medullated Fibers
1959	Rams	16	13	5.98	3.56	11.8	28.4	1.23	.04
	Ewes	16	30	5.89	3.30	10.2	24.6	1.62	.00
		23	28	5.82	3.28	8.8	23.1	1.26	.03
1960	Rams	16	15	7.85	4.08	11.9	30.7	1.41	.53
	Ewes	16	32	6.49	3.70	10.5	28.8	1.40	.40
		23	35	6.60	4.05	8.5	26.4	1.11	.02